CLAIMS

What is claimed is:

1. A method of controlling a power inverter comprising:

calculating x-y phasor components of inverter output current and voltage referenced to a desired x-y coordinate frame;

measuring real and reactive power output by the inverter based on the calculated x-y phasor components; and

adjusting the inverter output current and voltage to reduce a difference between the measured real and reactive powers and desired real and reactive powers.

2. The method of claim 1, wherein calculating the x-y phasor components comprises averaging over half-cycles of in-phase and quadrature components of single-phase voltage and current waveforms output by the inverter.

3. The method of claim 2, wherein averaging over half-cycles of in-phase and quadrature components of single-phase voltage and current waveforms output by the inverter comprises averaging over an integer number of half-cycles.

4. The method of claim 2, further comprising generating the in-phase and quadrature components by multiplying feedback signals corresponding to the inverter output voltage and current by in-phase (x) and quadrature (y) reference signals.

5. The method of claim 1, wherein calculating x-y phasor components of inverter output current and voltage referenced to a desired x-y coordinate frame comprises:

multiplying feedback signals corresponding to inverter output voltage and current by in-phase and quadrature reference signals to generate in-phase and quadrature measurement signals; and

integrating the in-phase and quadrature measurement signals over half-cycles of the inverter output voltage and current.

6. The method of claim 1, wherein measuring real and reactive power output by the inverter based on the calculated x-y phasor components comprises generating and summing selected product terms for in-phase and quadrature combinations of the x-y phasor components.

7. The method of claim 1, wherein adjusting the inverter output current and voltage to reduce a difference between the measured real and reactive power and desired real and reactive power comprises generating x-y control signals corresponding to desired in-phase and quadrature inverter output currents, and controlling the inverter based on the x-y control signals.

8. The method of claim 1, further comprising selectively referencing the x-y coordinate frame to one of an external reference signal and an internal reference signal.

9. The method of claim 8, wherein the inverter is a grid-connected inverter, and wherein selectively referencing the x-y coordinate frame to one of an external reference signal and an internal reference signal comprises referencing the x-y coordinate frame to

a grid voltage in a grid-connected mode of operation, and referencing the x-y coordinate frame to an internal reference voltage in a stand-alone mode of operation.

10. The method of claim 9, further comprising changing between grid-connected and stand-alone modes of operation based on detecting whether the grid is operating within nominal ranges for one or more electrical parameters.

11. The method of claim 1, further comprising referencing the x-y coordinate frame to an electrical parameter of a utility grid to which the inverter is connected.

12. The method of claim 11, wherein referencing the x-y coordinate frame to an electrical parameter of a utility grid to which the inverter is connected comprises aligning the x coordinate to a grid voltage such that x phasor components have a zero degree phase angle relative to the grid voltage and y phasor components have a ninety degree phase angle relative to the grid voltage.

13. The method of claim 1, wherein the inverter is a grid-connected inverter configured to operate in parallel with a utility grid, the method further comprising controlling an amount of reactive power output by the inverter to detect an islanding condition.

14. The method of claim 13, wherein controlling an amount of reactive power output by the inverter to detect an islanding condition comprises periodically increasing an amount of reactive power output by the inverter and determining whether the increase causes a shift in inverter output frequency.

15. The method of claim 13, wherein controlling an amount of reactive power output by the inverter to detect an islanding condition comprises periodically changing one or more control values used to set desired reactive power to cause a change in the reactive power output by the inverter, and determining that the inverter is operating in an island condition if an output frequency of the inverter shifts by more than a predetermined amount responsive to the change in reactive power output.

16. The method of claim 13, further comprising disconnecting the inverter from the grid responsive to detecting an islanding condition.

17. A regulator circuit for controlling a power inverter comprising:

a measurement circuit to measure real and reactive power output by the inverter based on calculating x-y phasor components of inverter output current and voltage referenced to a desired x-y coordinate frame; and

a feedback control circuit to control inverter voltage and current output based on a difference between the measured real and reactive powers and desired real and reactive powers.

18. The regulator circuit of claim 17, wherein the measurement circuit comprises a phasor calculator to calculate in-phase (x) and quadrature (y) fundament components of inverter output voltage and current, and a power calculator to generate measurements for the real and reactive power output by the inverter based on the fundamental components.

19. The regulator circuit of claim 18, wherein the phasor calculator comprises multipliers to generate in-phase and quadrature measurement signals for the inverter output voltage and current, and integrators to generate the fundamental components by integrating over half-cycles of the measurement signals.

20. The regulator circuit of claim 18, wherein the power calculator comprises product term generators to generate selected product terms of the fundamental components and summing circuits to generate measurements of real and reactive power output by the inverter based on the selected product terms.

21. The regulator circuit of claim 17, wherein the measurement circuit comprises one or more single-phase measurement circuits, each configured to measure real and reactive powers output by the inverter on a single-phase inverter output.

22. The regulator circuit of claim 17, wherein the feedback control circuit is configured to control inverter voltage and current output by generating x-y control signals corresponding to desired in-phase and quadrature inverter output currents, and controlling the inverter based on the x-y control signals.

23. The regulator circuit of claim 17, wherein the regulator circuit includes one or more reference signal inputs to receive x-y reference signals that define the desired x-y coordinate frame.

24. The regulator circuit of claim 17, further comprising detection logic to detect an islanding condition of the inverter based on detecting whether changing an amount of reactive power output by the inverter shifts an output frequency of the inverter.

25. A computer readable medium storing a computer program comprising:

program instructions to calculate x-y phasors for output voltage and output current from a power inverter configured to provide ac power;

program instructions to measure real and reactive power output by the inverter based on the x-y phasors;

program instructions to receive desired values for real and reactive power and to generate x-y control signals to control real and reactive power output by the inverter based on the measured real and reactive power and the desired values for real and reactive power.

26. The computer readable medium of claim 25, wherein the computer program further comprises program instructions to align an x-y coordinate frame used to generate the x-y phasors to a sensed grid voltage of a utility grid to which the inverter is connected.

27. The computer readable medium of claim 25, wherein the computer program further comprises program instructions to detect an islanding condition of the inverter by determining whether changing an amount of reactive power output by the inverter shifts an output frequency of the inverter.

28. The computer readable medium of claim 27, wherein the computer program instructions to detect an islanding condition of the inverter comprise program instructions to periodically change the amount of reactive power output by the inverter and monitor for a coincident change in frequency of the output voltage of the inverter.

29. A power inverter comprising:

an inverter circuit to output ac power;

a regulator circuit to control real and reactive power output by the inverter circuit, the regulator circuit comprising:

a measurement circuit to measure real and reactive power output by the inverter circuit based on calculating x-y phasor components for voltage and current waveforms output by the inverter circuit; and

a control circuit to control the real and reactive power output by the inverter circuit based on measured and desired real and reactive powers.

30. The power inverter of claim 29, wherein the regulator circuit further comprises a reference signal generator to generate in-phase and quadrature reference signals that establish an x-y coordinate frame for calculating the x-y phasor components.

31. The power inverter of claim 30, wherein, for a grid-connected configuration of the power inverter, the regulator circuit is configured to reference the x-y coordinate frame to a utility grid voltage phase.

32. The power inverter of claim 29, wherein the measurement circuit comprises phasor calculators configured to generate the x-y phasors by averaging over half-cycles of the voltage and current waveforms.

33. The power inverter of claim 29, wherein the power inverter further comprises islanding detection logic to detect an islanding condition of the power inverter based on determining whether an output frequency of the power inverter changes responsive to changing an amount of reactive power output by the inverter circuit.

34. The power inverter of claim 33, wherein the islanding detection logic is configured to periodically check for the islanding condition if the power converter is connected to a utility grid.

35. The power inverter of claim 34, wherein the power inverter further comprises one or more signal inputs and associated logic to detect whether the power inverter is connected to a utility grid.

36. The power inverter of claim 33, wherein the power inverter further comprises one or more signal outputs configured to output one or more disconnect signals responsive to detecting an islanding condition.